INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2004/001067

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl. [7]: G06N 1/00, H01L 29/15, G01R 29/24

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

DWPI, JAPIO Keywords: qubit, quantum; energ, well; coupl, tunnel; weak, adiabatic, afp, slow var, read out, tomograph, interrogat; control, adjust, scan, modulat; output

GOOGLE Keywords: adiabatic fast passage; quantum

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
P, X	A. D. Greentree *et al.*, "Charge shelving and bias spectroscopy for the readout of a charge qubit on the basis of superposition states", Physical Review B, 16 July 2004, vol. 70, article 041305 Whole document	1-41
P, X	A. D. Greentree *et al.*, "Electrical readout of a spin qubit without double occupancy" (online), 24 March 2004 (retrieved on 8 October 2004). Retrieved from the Internet <URL: http://xxx.lanl.gov/abs/cond-mat?0403449>. Whole document	1-41

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
11 October 2004	14 OCT 2004
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. (02) 6285 3929	Authorized officer **MICHAEL HALL** Telephone No : (02) 6283 2474

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C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5663571 A (UGAJIN) 2 September 1997 Whole document	1-41
A	Patent Abstracts of Japan, JP 09-326485 A (SONY CORP) 16 December 1997 Whole document	1-41
A	Hollenberg *et al.*, "Charge-based quantum computing using single donors in semiconductors" (online), 10 June 2003 (retrieved 11 October 2004). Retrieved from the Internet <URL: http://au.arxiv.org/abs/cond-mat?0306235>. Whole document	1-41
P, A	WO 2004/049252 A2 (D-WAVE SYSTEMS, INC.) 10 June 2004 Pages 26-29	1-41

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.
PCT/AU2004/001067

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report		Patent Family Member	
US	5663571	JP	7297381
JP	9326485	NONE	
WO	04049252	NONE	

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX

AMENDED CLAIMS

[received by the International Bureau on 14 December 2004 (14.12.04);
original claims 35-41 amended; new claim 42 added; remaining claims unchanged (5 pages)]

1. A closed three-site quantum particle system, comprising:

a first site in which the energy is controllable;

a second site in which the energy is controllable;

states in the first and second sites that are strongly coupled to each other by coherent tunnelling, and where the tunelling rate is controllable; and,

a third site in which the energy is controllable, and where the state in the third site is weakly coupled by coherent tunnelling to the first and second states, so that the third state is able to map out the populations of the first and second states as its energy is scanned with respect to the first and second states.

2. A system according to claim 1, wherein the first and second states are a solid-state charge qubit with one particle shared between the two sites.

3. A system according to claim 2, wherein the system is operated in the superposition basis with an integrated readout using the third site as a probe state.

4. A system according to claim 1, 2 or 3 wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

5. A system according to claim 4, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit are modulated to effect AFP.

6. A system according to claim 4, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

7. A system according to any preceding claim, wherein the energies and tunnelling rates are controlled using gate electrodes.

8. A system according to claim 7, wherein the voltages on the gate electrodes are controlled.

9. A system according to claim 7, wherein a sensitive electrometer is used for reading out the population in the third state.

10. A system according to claim 9, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

11. A system according to claim 10, wherein the electrometer is realised by a quantum point contact.

12. A system according to any preceding claim when used for readout from a quantum computer.

13. A system according to claim 1, wherein alternatively, the first site involves a solid-state spin qubit, and the second site involves a reference spin, and the third site is used as a probe site.

14. A system according to claim 13, wherein the relative spins of the first and second sites are converted into charge distribution information.

15. A system according to claim 13 or 14, wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

16. A system according to claim 15, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the reference states are modulated to effect AFP.

17. A system according to claim 16, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

18. A system according to any one of claims 13 to 16, wherein the energies and tunnelling rates are controlled using gate electrodes.

19. A system according to claim 18, wherein the voltages on the gate electrodes are controlled.

20. A system according to claim 19, wherein a sensitive electrometer is used for reading out the population in the third state.

21. A system according to claim 20, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

22. A system according to claim 21, wherein the electrometer is realised by a quantum point contact.

23. A system according to any one of claims 13 to 21, applied to readout from a quantum computer.

24. A system according to claim 23, wherein the quantum computer uses nuclear spin or electron spin qubits.

25. A system according to claim 1, wherein the system is used with flux quanta or 2D electron gas, and a third state introduced for readout.

26. A readout method for a closed three-state quantum particle system, comprising the following steps:

controlling the energy of a first site;

controlling the energy of a second site;

controlling the tunnelling rate between the first and second sites, which are strongly coupled to each other by coherent tunnelling; and,

controlling the energy of a third site, the state in the third site being weakly coupled by coherent tunnelling to the first and second states, so the third state is able to map out the populations of the first and second states as its energy is scanned with respect to the first and second states.

27. A method according to claim 26 wherein Adiabatic Fast Passage (AFP) is employed as a readout mechanism.

28. A method according to claim 27, wherein the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit are modulated to effect AFP.

29. A method according to claim 27, wherein the AFP trajectory is reversed to re-initialise the qubit into a known state.

30. A method according to any one of claims 26 to 29, wherein the energies and tunnelling rates are controlled using gate electrodes.

31. A method according to claim 30, wherein the voltages on the gate electrodes are controlled.

32. A method according to claim 30, wherein a sensitive electrometer is used for reading out the population in the third state.

33. A method according to claim 32, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

34. A system according to claim 32, wherein the electrometer is realised by a quantum point contact.

35. [Amended] A readout method for a closed three-state quantum particle system, comprising the following steps:

mapping the system onto different energy states which are resolvable within the linewidth limitations of controlled tunnelling to a probe state, wherein the mapping requires two or more parameters to be modulated to force the system to remain on a specific adiabatic pathway and resolving the states using bias spectroscopy methods to produce readout.

36. [New] A readout method according to claim 35, wherein the parameters are the difference between the probe energy and the qubit, and the tunnelling rate between the probe and the qubit or reference state.

37. [Renumbered] A method according to claim 35 or 36, comprising the further step of re-initialisation by reversing the AFP trajectory so that the qubit is set into a known state.

38. [Renumbered] A method according to any one of claims 35 to 37, wherein the energies and tunnelling rates are controlled using gate electrodes.

39. [Renumbered] A method according to claim 38, wherein the voltages on the gate electrodes are controlled.

40. [Renumbered] A method according to claim 39, wherein a sensitive electrometer is used for reading out the population in the third state.

41. [Renumbered] A method according to claim 40, wherein the electrometer is realised by a single electron transistor (SET) which monitors the charge in the third, weakly coupled, site.

42. [Renumbered] A system according to claim 41, wherein the electrometer is realised by a quantum point contact.